

## Equation Listing

Column	Name	Formula	Description
A	Company	The data for this sheet is taken from output sheet of the distribution module.	
B	operating company indicator		
C	wire center		
D	CBG geocode		
E	quadrant		
F	main feeder distance		
G	subfeeder		
H	distribution distance		
I	total lines		
J	density, lines/sq mi		
K	area, sq mi		
L	business lines		
M	residential lines		
N	SA lines		
O	public lines		
P	households		
Q	single-line business lines		
R	distribution cable, underground		
S	distribution cable, buried		
T	distribution cable, aerial		
U	distribution conduit		
V	distribution conduit placement		
W	distribution poles		
X	distribution buried plcmt		
Y	rock plcmt mult		
Z	difficult surface mult		
AA	water table depth, ft		
AB	effective distribution cable fill		
AC	number of TR-303 RTs		
AD	TR-303 investment		

## Equation Listing

Column	Name	Formula	Description
AE	number of low-density DLC RTs		
AF	low-density DLC investment		
AG	fiber strands required		
AH	SAI inv		
AI	terminal inv		
AJ	drop inv		
AK	NID inv		
AL	number of DLC lines		
AM	vertical connecting cable length, ft		
AN	horizontal connecting cable length, ft		
AO	vertical structure distance, ft		
AP	horizontal structure distance, ft		
AQ	average loop length, ft		
AR	maximum loop length, ft		
AS	cluster ID		
AT	cluster serial number		
AU	wireless cap indicator		
AV	lines affected by wireless cap		
AW	cable+structure+DLC inv less wireless estimate		
AX	calc buried fraction -- main cluster		
AY	calc aerial fraction -- main cluster		
AZ	calc u/g fraction -- main cluster		
BA	overall wtd avg loop length		
BB	cluster fraction of wire center lines		

## Equation Listing

Column	Name	Formula	Description
A	wire center	=distribution input!C2	Wire center serving this cluster
B	Quadrant	=distribution input!E2	Quadrant where this cluster is located.
C	main feeder distance, ft	=distribution input!F2	Main feeder distance from the wire center to the subfeeder splice for this cluster
D	subfeeder distance	=distribution input!G2	Subfeeder distance from the main feeder splice to the center of this cluster
E	basic lines	=distribution input!I2	Total lines in cluster
F	line density per sq mi	=distribution input!J2	Repeats line density in lines/sq mi for cluster
G	strands required	=distribution input!AG2	Number of fiber strands required to serve the DLC remote terminal(s)
H	copper subfeeder size	=IF(OR(subfeeder_dist=0,basic_segment_type="DLC"),"N/A",AJ2)	repeats assigned copper subfeeder cable cross section, if equipped
I	current segment inv	=IF(AG2=0,0,X2*(AH2*max_copper_inv+VLOOKUP(AG2,copper_inv,2,FALSE)*((1-wtg_copper_const)+wtg_copper_const*labor_adj)))	Investment in copper feeder cable required for feeder segment serving cluster
J	max copper cable inv (subfeeder)	=IF(basic_segment_type<>"Cable",0,max_copper_inv*(subfeeder_dist*AK2)*((1-wtg_copper_const)+wtg_copper_const*labor_adj))	calculates investment in maximum (overflow) copper subfeeder cables, if present
K	fiber subfeeder size	=IF(AND(subfeeder_dist<>0,basic_segment_type="DLC"),MAX(min_fiber_subfdr, INDEX(fiber_range,MATCH('distribution input'!\$AG2/VLOOKUP(line_density,density_inputs,3),fiber_range,-1),1)),"N/A")	assigns cable size for fiber subfeeder cable
L	fiber subfeeder investment	=IF(K2="N/A",0,(subfeeder_dist+'distribution input'!AN2+'distribution input'!AM2)*VLOOKUP(K2,fiber_inv,2,FALSE))	calculates fiber subfeeder cable investment
M	fiber main segment investment	=IF(AC2=0,0,X2*VLOOKUP(AL2,fiber_inv,2,FALSE)+AM2*max_fiber_inv*X2)	calculates investment in fiber cable for feeder segment serving cluster, including investment in any overflow cables
N	fiber subfeeder segment investment	=IF(basic_segment_type="DLC",L2,0)	Repeats investment in fiber subfeeder cable
O	segment number	=IF(this_wire_cntr=0,0,IF(AND(this_wire_cntr=next_wire_cntr,this_quadrant=next_quadrant),O3+1,1))	Numbers clusters along feeder route beginning at 1 for cluster nearest wire center
P	segment investment per line	=IF(AD2=0,0,I2/AD2)	Divides segment investment for copper cable by number of lines in current cluster and sum of lines in all clusters served by copper more distant from the wire center
Q	cumulative investment per line	=IF(OR(O1=1,ISTEXT(Q1)),P2,P2+Q1)	Accumulates investment per line in copper cable from wire center end of feeder route

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Column	Name	Formula	Description
R	assigned copper cable investment	=IF(basic_segment_type="Cable",basic_lines*Q2,0)	assigns copper cable investment to cluster by multiplying segment investment per line by number of lines in cluster
S	segment investment per strand	=IF(AC2=0,0,M2/AC2)	calculates investment per strand of fiber cable for segment serving this cluster
T	cumulative investment per strand	=IF(OR(O1=1,ISTEXT(T1)),S2,S2+T1)	Accumulates investment per strand along feeder route, beginning at wire center end of route
U	assigned fiber investment	=G2*T2	Assigns share of fiber cable investment to cluster
V	max distance	=IF(OR(W3=1,ISBLANK(W3)),C2,V3)	Computes and repeats maximum distance along feeder route
W	cluster sequence number	=IF(OR(this_quadrant<>B1,this_wire_cntr<>A1),1,W1+1)	Numbers cluster appearance along feeder route, beginning at wire center
X	segment distance	=IF(AND(this_wire_cntr=A1,this_quadrant=B1),C2-C1,C2)	Computes length of main feeder segment connecting previous cluster to current cluster
Y	basic segment type	=IF(this_wire_cntr="", "", IF(G2=0,"Cable","DLC"))	Indicates whether segment is served by fiber feeder ("DLC") or copper feeder ("Cable")
Z	secondary segment type	=IF(this_quadrant=0,"",IF(OR(W3=1,AND(this_wire_cntr=next_wire_cntr,this_quadrant=next_quadrant,basic_segment_type=Y3,ISBLANK(Z3))), "",IF(basic_segment_type<>Y3,Y3,Z3)))	Indicates whether clusters farther along feeder route from current cluster use feeder cable type different from that used by current cluster
AA	cumulative required copper pairs	=IF(basic_segment_type="Cable",IF(OR(W3=1,AND(W3<>1,basic_segment_type<>Y3,next_quadrant<>this_quadrant,Z2<>"Cable"),ISBLANK(AA3)),basic_lines/VLOOKUP(line_density,density_inputs,2),basic_lines/VLOOKUP(line_density,density_inputs,2)+AA3),IF(W3=1,0,AA3))	Accumulates required copper cable pair count, including cable sizing factor, from far end of cable toward wire center
AB	cumulative lines served by fiber	=IF(basic_segment_type="DLC",IF(OR(W3=1,AND(W3<>1,basic_segment_type<>Y3,Z2<>"DLC"),ISBLANK(AB3)),basic_lines,basic_lines+AB3),IF(Z2="DLC",AB3,0))	accumulates lines served by fiber from remote end of feeder route
AC	total number of fiber strands	=IF(AB2=0,0,IF(W3=1,G2,IF(AB2=AB3,AC3,G2+AC3)))	accumulates number of fiber strands required from remote end of feeder route
AD	cumulative copper lines	=IF(basic_segment_type="Cable",IF(OR(W3=1,AND(W3<>1,basic_segment_type<>Y3,next_quadrant<>this_quadrant,Z2<>"Cable"),ISBLANK(AA3)),basic_lines,basic_lines+AD3),IF(W3=1,0,AD3))	accumulates lines served by copper from remote end of feeder route
AE	cumulative fiber lines	=IF(basic_segment_type="DLC",IF(OR(W3=1,AND(W3<>1,basic_segment_type<>Y3,next_quadrant<>this_quadrant,Z2<>"DLC"),ISBLANK(AA3)),basic_lines,basic_lines+AE3),IF(W3=1,0,AE3))	Computes cumulative fiber line count from far end of feeder route for use in feeder conduit calculation
AF	calc copper feeder fill	=IF(OR(AG2=0,basic_segment_type="DLC"),0,AD2/(AG2+AH2*max_copper))	calculates achieved copper feeder fill factor for segment serving cluster

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Column	Name	Formula	Description
AG	equipped feeder cable	=IF(AA2<>0,INDEX(copper_range,MATCH(AA2-(max_copper*AH2),copper_range,-1),1),0)	determines feeder cable size in segment serving cluster
AH	number of maximum-sized main feeder cables	=TRUNC(IF(AA2>max_copper,AA2/max_copper,0))	computes number of "overflow," or maximum-sized, main feeder cables required, if any
AI	sub cable pairs	=IF(basic_segment_type="Cable",basic_lines/VLOOKUP(line_density,density_inputs,2),0)	determines number of copper pairs required in subfeeder cable to serve cluster; includes effect of cable sizing factor
AJ	sub cable size	=IF(AI2<>0,INDEX(copper_range,MATCH(AI2-(max_copper*AK2),copper_range,-1),1),0)	Assigns subfeeder cable size
AK	max sub cables	=TRUNC(IF(AI2>max_copper,AI2/max_copper,0))	Calculates number of overflow subfeeder copper cables, if any
AL	fiber cable size	=IF(AC2=0,0,INDEX(fiber_range,MATCH(AC2/VLOOKUP(line_density,density_inputs,3)-max_fiber*TRUNC(AC2/(max_fiber*VLOOKUP(line_density,density_inputs,3))),fiber_range,-1),1))	assigns fiber cable cross section for segment serving cluster.
AM	max fiber cables	=IF(AC2/VLOOKUP(line_density,density_inputs,3)>max_fiber,TRUNC(AC2/(max_fiber*VLOOKUP(line_density,density_inputs,3))),0)	calculates number of overflow fiber cables main feeder segment serving this cluster, if required
AN	fiber segment cumulative distance	=IF(AND(basic_segment_type<>"DLC",Z2<>"DLC"),0,IF(AND(this_wire_cntr=A1,this_quadrant=B1),X2+AN1,X2))	accumulates fiber segment distance beginning at wire center end of feeder route
AO	fiber segment total distance from end	=IF(OR(basic_segment_type="DLC",Z2="DLC"),IF(OR(W3=1,AND(Y3<>"DLC",Z3<>"DLC")),AN2,AO3),0)	Calculates distance from cluster to end of fiber route
AP	copper feeder conduit inv	=IF(OR(basic_segment_type="Cable",Z2="Cable"),(X2*(1+AH2+spare_tubes_sect))*BU2*conduit_mat_inv_ft,0)	Computes investment in conduit for copper feeder cable for segment, including spare tubes and tubes for overflow cables, if any
AQ	copper feeder manholes	=IF(OR(basic_segment_type="Cable",Z2="Cable"),X2*BU2/VLOOKUP(line_density,density_inputs,7)*(VLOOKUP(line_density,density_inputs,17)+IF('distribution input'!AA2<=water_thresh,(min_water_factor+(max_water_factor-min_water_factor)/water_thresh)*(water_thresh-'distribution input'!AA2))*VLOOKUP(line_density,inputs!\$B\$16:\$G\$24,6),0)),0)	Computes investment in manholes for copper feeder cable; includes extra investment for dewatering, which varies linearly with water table depth
AR	copper feeder u/g trenching	=IF(basic_segment_type="Cable",X2*BU2*VLOOKUP(line_density,density_inputs,9)*((1-wtg_excav)+wtg_excav*labor_adj)*('distribution input'!Y2+'distribution input'!Z2-1),0)	Computes investment in underground placement for segment
AS	copper feeder buried placement	=IF(basic_segment_type="Cable",X2*BS2*VLOOKUP(line_density,density_inputs,8)*((1-wtg_excav)+wtg_excav*labor_adj)*('distribution input'!Y2+'distribution input'!Z2-1),0)	Calculates investment in buried feeder placement for segment

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Column	Name	Formula	Description
AT	copper feeder pole inv	=IF(basic_segment_type="Cable", (1+CEILING(X2*BT2/VLOOKUP(line_density, density_inputs,19),1))*(pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj)) *('distribution input'!Y2+'distribution input'!Z2-1),0)	Computes investment in feeder poles for copper cable; poles carry both copper and optical fiber cable when required
AU	fiber feeder conduit inv	=IF(AND(basic_segment_type="Cable",Z2<>"DLC"),0,IF(AO2=0,0,1/AO2*V2*X2*BX2*((1+spare_tubes_sect)*(conduit_mat_inv_ft)+AM2*inner_duct_inv_ft)))	Computes investment in conduit for underground fiber feeder cable, including any required inner duct for overflow cable
AV	fiber fdr pullboxes	=IF(basic_segment_type<>"Cable",IF(AQ2<>0,0,X2*BX2/VLOOKUP(line_density,density_inputs,13)*VLOOKUP(line_density,density_inputs,18)),0)	Calculates investment for pullboxes for fiber feeder cable in segment
AW	fiber feeder u/g trenching	=IF(basic_segment_type<>"Cable",X2*BX2*VLOOKUP(line_density,density_inputs,15)*((1-wtg_excav)+wtg_excav*labor_adj)*('distribution input'!Y2+'distribution input'!Z2-1),0)	Computes investment in placement for underground fiber cable for segment
AX	fiber feeder buried placement	=IF(basic_segment_type<>"Cable",X2*BV2*VLOOKUP(line_density,density_inputs,14)*((1-wtg_excav)+wtg_excav*labor_adj)*('distribution input'!Y2+'distribution input'!Z2-1),0)	Calculates investment in buried placement for fiber feeder cable for this segment
AY	fiber feeder poles	=IF(basic_segment_type<>"Cable", (1+CEILING((X2)*BW2/VLOOKUP(line_density,density_inputs,19),1))*(pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj)) *('distribution input'!Y2+'distribution input'!Z2-1),0)	Computes investment in feeder poles for fiber cable for this segment
AZ	cumulative number of lines	=IF(O2=1,basic_lines,basic_lines+AZ3)	Accumulates total lines from remote end of feeder route.
BA	copper feeder conduit segment inv per line	=IF(AD2=0,0,AP2/AD2)	Computes copper conduit investment for the current segment per line
BB	cumulative conduit inv per line	=IF(OR(O1=1,ISTEXT(BB1)),BA2,BA2+BB1)	accumulates per-line conduit investment from beginning of feeder route
BC	assigned copper feeder conduit inv	=IF(basic_segment_type="Cable",basic_lines*BB2+subfeeder_dist*(1+AK2+spare_tubes_sect)*BU2*conduit_mat_inv_ft,0)	Computes cluster's share of copper conduit investment plus conduit required for copper subfeeder. Note that connecting cable and structure distances do not affect this calculation because they are only used with fiber feeder
BD	total feeder manhole sgmt inv per line	=IF(AZ2=0,0,(AQ2+AV2)/AZ2)	computes manhole and pullbox investment per cumulative line
BE	cumulative inv per line	=IF(OR(O1=1,ISTEXT(BE1)),BD2,BD2+BE1)	accumulates per-line investment in manholes and pullboxes from beginning of route

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BF	assigned total feeder manhole inv	=IF(basic_segment_type="Cable",subfeeder_dist*BU2/VLOOKUP(line_density,density_inputs,7)*VLOOKUP(line_density,density_inputs,17),(subfeeder_dist+'distribution input'!AO2+'distribution input'!AP2)*BX2/VLOOKUP(line_density,density_inputs,13)*VLOOKUP(line_density,density_inputs,18))+basic_lines*BE2	assigns manhole and pullbox investment to current cluster according to total lines in cluster; includes investment required for subfeeder (with connecting cables, if present)
BG	total feeder u/g placement segment inv per line	=IF(AZ2=0,0,(AR2+AW2)/AZ2)	calculates total underground (conduit) placement investment per line
BH	cumulative u/g placement investment per line	=IF(OR(O1=1,ISTEXT(BH1)),BG2,BG2+BH1)	accumulates feeder (conduit) underground placement investment per line
BI	assigned total feeder u/g placement inv	=IF(basic_segment_type="Cable",subfeeder_dist*BU2*VLOOKUP(line_density,density_inputs,9)*((1-wtg_excav)+wtg_excav*labor_adj),(subfeeder_dist+'distribution input'!AO2+'distribution input'!AP2)*BX2*VLOOKUP(line_density,density_inputs,15)*((1-wtg_excav)+wtg_excav*labor_adj))*(distribution input'!Y2+'distribution input'!Z2-1)+basic_lines*BH2	Assigns cluster share of main feeder underground placement investment according to lines in cluster; adds subfeeder placement
BJ	total feeder buried placement segment inv per line	=IF(AZ2=0,0,(AS2+AX2)/AZ2)	calculates buried placement investment for current segment expressed per line
BK	cumulative buried placement investment per line	=IF(OR(O1=1,ISTEXT(BK1)),BJ2,BJ2+BK1)	accumulates buried placement investment per line from beginning of feeder route
BL	assigned total feeder buried placement inv	=IF(basic_segment_type="Cable",subfeeder_dist*BS2*VLOOKUP(line_density,density_inputs,8)*((1-wtg_excav)+wtg_excav*labor_adj),(subfeeder_dist+'distribution input'!AO2+'distribution input'!AP2)*BV2*VLOOKUP(line_density,density_inputs,14)*((1-wtg_excav)+wtg_excav*labor_adj))*(distribution input'!Y2+'distribution input'!Z2-1)+basic_lines*BK2	computes cluster's share of total buried placement investment according to lines in cluster; includes subfeeder buried placement and connecting cables for fiber subfeeder, when present
BM	feeder pole segment inv per line	=IF(AZ2=0,0,(AT2+AY2)/AZ2)	calculates feeder pole investment for current segment per line
BN	cumulative inv per line	=IF(OR(O1=1,ISTEXT(BN1)),BM2,BM2+BN1)	Accumulates feeder pole investment per line from beginning of feeder route

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Column	Name	Formula	Description
BO	assigned feeder pole inv	=basic_lines*BN2+IF(basic_segment_type="Cable", (1+CEILING(subfeeder_dist*B T2/VLOOKUP(line_density,density_inputs,19),1))*(pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj)) *('distribution input'!Y2+'distribution input'!Z2-1),0)+IF(basic_segment_type<>"Cable", (1+CEILING((subfeeder_dist+'distribution input'!AO2+'distribution input'!AP2)*BW2/VLOOKUP(line_density,density_inputs,19),1))*(pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj)) *('distribution input'!Y2+'distribution input'!Z2-1),0)	assigns feeder pole investment to cluster according to total lines in cluster; includes subfeeder poles
BP	fiber feeder conduit segment inv per line	=IF(AE2=0,0,AU2/AE2)	Computes per-line investment in conduit containing fiber feeder cable per line
BQ	cumulative inv per line	=IF(OR(O1=1,ISTEXT(BQ1)),BP2,BP2+BQ1)	accumulates fiber conduit investment per line from beginning of feeder route
BR	assigned fiber feeder conduit inv	=IF(basic_segment_type="DLC",basic_lines*BQ2,0)+IF(basic_segment_type="Cable",0,IF(AO2=0,"",(subfeeder_dist+'distribution input'!AO2+'distribution input'!AP2)*BU2*(conduit_mat_inv_ft*(1+spare_tubes_sect))))	Assigns fiber conduit investment to cluster according to total lines in cluster; includes subfeeder conduit
BS	effective copper buried fraction	=VLOOKUP(line_density,density_inputs,5)+CF2	Computes effective buried structure fraction according to local conditions and user-set input values
BT	effective copper aerial fraction	=MAX(0,1-BS2-BU2)	computes effective aerial structure fraction for copper cable from buried and underground fractions
BU	effective copper u/g fraction	=VLOOKUP(line_density,density_inputs,6)	Repeats user-selected copper cable underground fraction for cluster density range
BV	effective fiber buried fraction	=VLOOKUP(line_density,density_inputs,11)+CN2	Computes effective buried fiber cable structure fraction according to local conditions and user-set input values
BW	effective fiber aerial fraction	=MAX(0,1-BV2-BX2)	computes effective aerial structure fraction for fiber cable from buried and underground fractions
BX	effective fiber u/g fraction	=VLOOKUP(line_density,density_inputs,12)	Repeats user-selected fiber cable underground fraction for cluster density range
BY	copper buried investment/foot, cable + placement, with sharing	=IF(Y2="Cable",((AH2*max_copper_inv+VLOOKUP(AG2,copper_inv,2,FALSE))*inputs!\$C\$57+VLOOKUP(line_density,density_inputs,28))*((1-wtg_copper_const)+wtg_copper_const*labor_adj),0)	Computes total copper buried investment per foot, including placement and structure sharing
BZ	copper aerial investment/foot, cable	=IF(Y2="Cable",((AH2*max_copper_inv+VLOOKUP(AG2,copper_inv,2,FALSE))*((1-wtg_copper_const)+wtg_copper_const*labor_adj)),0)	Calculates aerial copper cable investment per foot

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Column	Name	Formula	Description
CA	copper aerial investment/foot, pole, with sharing	=IF(Y2="Cable", (pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj))/VLOOKUP(line_density,density_inputs,19)*VLOOKUP(line_density,density_inputs,20),0)	Calculates pole investment per foot for copper cables, including effects of pole sharing
CB	std copper buried LC cost/ft, with sharing	=BY2*(LCFactors!\$C\$3+LCFactors!\$D\$3)	Computes life cycle cost/ft of buried cable, including capital carrying costs, maintenance costs, and effects of structure sharing; result represents "standard" cost unaffected by local conditions
CC	std copper aerial LC cost/ft, with sharing	=BZ2*(LCFactors!\$C\$5+LCFactors!\$D\$5)+CA2*(LCFactors!\$C\$9+LCFactors!\$D\$9)	Computes life cycle cost/ft of aerial cable, including capital carrying costs, maintenance costs, and effects of structure sharing; result represents "standard" cost unaffected by local conditions
CD	local copper buried LC cost/ft, w/sharing	=IF(Y2="Cable", ((AH2*max_copper_inv+VLOOKUP(AG2,copper_inv,2,FALSE))*inputs!\$C\$57+(distribution input'!Y2+distribution input'!Z2-1)*VLOOKUP(line_density,density_inputs,28))*((1-wtg_copper_const)+wtg_copper_const*labor_adj),0)*(LCFactors!\$C\$3+LCFactors!\$D\$3)	Computes life cycle cost/ft of buried cable, including capital carrying costs, maintenance costs, and effects of structure sharing and local rock and difficult surface conditions; result represents local cost adjusted to local conditions
CE	local copper aerial LC cost/ft, w/sharing	=IF(Y2="Cable", BZ2*(LCFactors!\$C\$5+LCFactors!\$D\$5)+(pole_materials+(distribution input'!Y2+distribution input'!Z2-1)*pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj))/VLOOKUP(line_density,density_inputs,19)*VLOOKUP(line_density,density_inputs,20)*(LCFactors!\$C\$9+LCFactors!\$D\$9),0)	Computes life cycle cost/ft of aerial cable, including capital carrying costs, maintenance costs, and effects of structure sharing and local rock and difficult surface conditions; result represents "local" cost adjusted for local conditions
CF	copper buried adjustment	=IF(Y2="Cable", (0.5-1/(1+(CB2/CC2)/((CD2/CE2)^inputs!\$G\$82)))*VLOOKUP(line_density,density_inputs,23),0)	Calculates adjustment to input buried structure fraction for local density range using user-specified buried "swing" factor and standard and local cost inputs to logistic function
CG	fiber buried investment/foot, cable + placement, with sharing	=IF(Y2="DLC", VLOOKUP(AL2,fiber_inv,2,FALSE)+inputs!\$C\$58+AM2*(max_fiber_inv+inputs!\$C\$58)+VLOOKUP(line_density,density_inputs,29),0)	Computes total fiber buried investment per foot, including placement and structure sharing
CH	fiber aerial investment/foot, cable	=IF(Y2="DLC", VLOOKUP(AL2,fiber_inv,2,FALSE)+AM2*(max_fiber_inv),0)	Calculates aerial fiber cable investment per foot
CI	fiber aerial investment/foot, pole, with sharing	=IF(Y2="DLC", (pole_materials+pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj))/VLOOKUP(line_density,density_inputs,19)*VLOOKUP(line_density,density_inputs,24),0)	Calculates pole investment per foot for fiber cables, including effects of pole sharing
CJ	std fiber buried LC cost/ft, with sharing	=CG2*(LCFactors!\$C\$4+LCFactors!\$D\$4)	Computes life cycle cost/ft of buried cable, including capital carrying costs, maintenance costs, and effects of structure sharing; result represents "standard" cost unaffected by local conditions

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CK	std fiber aerial LC cost/ft, with sharing	=CH2*(LCFactors!\$C\$6+LCFactors!\$D\$6)+CI2*(LCFactors!\$C\$9+LCFactors!\$D\$9)	Computes life cycle cost/ft of aerial cable, including capital carrying costs, maintenance costs, and effects of structure sharing; result represents "standard" cost unaffected by local conditions
CL	local fiber buried LC cost/ft, w/sharing	=IF(Y2="DLC",VLOOKUP(AL2,fiber_inv,2,FALSE)+inputs!\$C\$58+AM2*(max_fiber_inv+inputs!\$C\$58)+('distribution input'!Y2+'distribution input'!Z2-1)*VLOOKUP(line_density,density_inputs,29),0)*(LCFactors!\$C\$4+LCFactors!\$D\$4)	Computes life cycle cost/ft of buried cable, including capital carrying costs, maintenance costs, and effects of structure sharing and local rock and difficult surface conditions; result represents local cost adjusted to local conditions
CM	local fiber aerial LC cost/ft, w/sharing	=IF(Y2="DLC",CH2*(LCFactors!\$C\$6+LCFactors!\$D\$6)+(pole_materials+('distribution input'!Y2+'distribution input'!Z2-1)*pole_labor*((1-wtg_pole_set)+wtg_pole_set*labor_adj))/VLOOKUP(line_density,density_inputs,19)*VLOOKUP(line_density,density_inputs,24)*(LCFactors!\$C\$9+LCFactors!\$D\$9),0)	Computes life cycle cost/ft of aerial cable, including capital carrying costs, maintenance costs, and effects of structure sharing and local rock and difficult surface conditions; result represents "local" cost adjusted for local conditions
CN	fiber buried adjustment	=IF(Y2="DLC", (0.5-1/(1+(CJ2/CK2)/((CL2/CM2)*inputs!\$G\$82)))*VLOOKUP(line_density,density_inputs,27),0)	Calculates adjustment to input fiber buried structure fraction for local density range using user-specified buried "swing" factor and standard and local cost inputs to logistic function

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Column	Name	Formula	Description
A	wire center	=distribution input!C2	repeats wire center location ID from distribution input sheet
B	operating company	=distribution input!A2	repeats company name from distribution input sheet
C	CBG	=distribution input!D2	repeats CBG from distribution input sheet
D	operating company indicator	=distribution input!B2	repeats operating company type indicator from distribution input sheet
E	total lines	=distribution input!I2	repeats total lines from distribution input sheet
F	business lines	=distribution input!L2	repeats business lines from distribution input sheet
G	res lines	=distribution input!M2	repeats residential line total from distribution input sheet
H	SA lines	=distribution input!N2	repeats special access line total from distribution input sheet
I	public lines	=distribution input!O2	repeats public line total from distribution input sheet
J	households	=distribution input!P2	repeats household total from distribution input sheet
K	single-line business lines	=distribution input!Q2	repeats single-line business line total from distribution input sheet
L	area, sq mi	=distribution input!K2	repeats area from distribution input sheet
M	density lines/sq mi	=distribution input!J2	repeats line density from distribution input sheet
N	density range	=VLOOKUP(M2,density_inputs,16)	repeats density range from distribution input sheet
O	cpr fdr cbl inv, u/g	=('cable inv'!\$R2+'cable inv'!J2)*'cable inv'!BU2+IF('cable inv'!H2="N/A",0,'cable inv'!D2*VLOOKUP('cable inv'!H2,copper_inv,2,FALSE)*'cable inv'!BU2)	computes overall feeder copper cable investment for underground placement, including effect of regional labor multiplier
P	cpr fdr cbl inv, buried	=('cable inv'!\$R2+'cable inv'!J2)*'cable inv'!BS2*inputs!\$C\$57+IF('cable inv'!H2="N/A",0,'cable inv'!D2*VLOOKUP('cable inv'!H2,copper_inv,2,FALSE)*'cable inv'!BS2)*inputs!\$C\$57	computes overall feeder copper cable investment for buried placement, including effect of regional labor multiplier
Q	cpr fdr cbl inv, aerial	=('cable inv'!\$R2+'cable inv'!J2)*'cable inv'!BT2+IF('cable inv'!H2="N/A",0,'cable inv'!D2*VLOOKUP('cable inv'!H2,copper_inv,2,FALSE)*'cable inv'!BT2)	computes overall feeder copper cable investment for aerial placement, including effect of regional labor multiplier
R	fiber fdr cbl inv, u/g	=('cable inv'!\$U2+'cable inv'!N2)*'cable inv'!BX2	computes overall feeder fiber cable investment for underground placement
S	fiber fdr cbl inv, buried	=('cable inv'!\$U2+'cable inv'!N2+IF('cable inv'!Y2<>"Cable",('cable inv'!D2+'cable inv'!X2+'distribution input'!AM2+'distribution input'!AN2)*inputs!\$C\$58,0))*'cable inv'!BV2	computes overall feeder fiber cable investment for buried placement,

## Equation Listing

Column	Name	Formula	Description
T	fiber fdr cbl inv aerial	=('cable inv'!\$U2+'cable inv'!N2)*'cable inv'!BW2	computes overall feeder fiber cable investment for aerial placement
U	fdr conduit inv	='cable inv'!BC2+'cable inv'!BR2	calculates total conduit investment as sum of copper and fiber investments
V	feeder manhole inv	='cable inv'!BF2	repeats feeder manhole investment (includes pullboxes for fiber)
W	feeder u/g copper plcmt inv	=IF('cable inv'!\$Y2="Cable",'cable inv'!\$BI2,0)	repeats underground copper placement investment
X	feeder u/g fiber plcmt inv	=IF('cable inv'!\$Y2="DLC",'cable inv'!\$BI2,0)	repeats feeder underground fiber placement investment
Y	feeder buried copper plcmt inv	=IF('cable inv'!\$Y2="Cable",'cable inv'!\$BL2,0)	repeats feeder buried copper placement investment
Z	feeder buried fiber plcmt inv	=IF('cable inv'!\$Y2="DLC",'cable inv'!\$BL2,0)	repeats feeder buried fiber placement investment
AA	feeder pole inv	='cable inv'!BO2	repeats feeder pole investment
AB	dist cable inv, underground	='distribution input'!R2	repeats distribution underground cable investment
AC	dist cable inv, buried	='distribution input'!S2	repeats buried distribution cable investment
AD	dist cable inv, aerial	='distribution input'!T2	repeats distribution aerial cable investment
AE	distribution conduit inv	='distribution input'!U2	repeats distribution conduit investment
AF	distribution conduit plcmt inv	='distribution input'!V2	repeats distribution underground conduit placement investment
AG	dist buried plcmt inv	='distribution input'!X2	repeats distribution buried placement investment
AH	dist pole inv	='distribution input'!W2	repeats distribution pole investment
AI	calc cpr fdr fill	='cable inv'!AF2	repeats calculated copper feeder achieved fill at cluster
AJ	calc dist fill	='distribution input'!AB2	repeats calculated distribution achieved fill
AK	calc "mainframe" fill	=IF(AND('cable inv'!W2=1,'cable inv'!Y2="Cable"),output!AI2,0)	selects achieved copper feeder fill at first cluster along copper feeder cable route; equivalent to fill at mainframe
AL	DLC inv w/site	='distribution input'!AD2+'distribution input'!AF2	repeats DLC investment
AM	SAI inv	='distribution input'!AH2	repeats SAI investment
AN	terminal inv	='distribution input'!AI2	repeats terminal investment
AO	drop inv	='distribution input'!AJ2	repeats drop investment
AP	NID inv	='distribution input'!AK2	repeats NID investment

Workbook: **R50A\_feeder.xls**  
Worksheet: **output**

## Equation Listing

**HAI Model, v5.0A  
Feeder Module**

Column	Name	Formula	Description
AQ	feeder distance	='cable inv'!X2+'cable inv'!D2	calculates incremental distance from previous cluster plus subfeeder distance
AR	total dist distance	='distribution input'!H2	repeats total distribution structure distance
AS	DLC lines	=IF('cable inv'!Y2="DLC",'cable inv'!E2,0)	repeats number of lines served by DLC
AT	wtd cluster average loop length	='distribution input'!BA2*'distribution input'!BB2	Calculates average loop length for cluster weighted by fraction of total wire center lines in cluster for use by interface in computing weighted average loop length for wire center
AU	cluster serial number	='distribution input'!AT2	repeats cluster serial number from distribution input sheet